

REMARKS

By this amendment, Applicants have amended the claims to more clearly define their invention. In particular, claims 1 and 11 have been amended to clarify that the graphite particles having an average particle size of not more than 3 μm are present in a section of the metal structure of the steel, thereby avoiding the phrase “there can be observed,” which the Office Action appears to misinterpret. Claim 1 has been amended to change “a steel” in the last line to read --the steel--. Claim 11 has been amended to indicate that the steel comprises S (sulfur).

Applicants have also added new claims 22-25 to define further aspects of the present invention. Claims 22 and 24 are supported by, e.g., the description at page 21, lines 8-10 of Applicants’ specification. Claims 23 and 25 are supported by, e.g., Specimen No. 1 in Table 1 on page 37 of Applicants’ specification and the description from page 16, line 27 to page 17, line 5 and page 21, lines 2-22 of Applicants’ specification. Claims 2-4, 6-8 and 10 have been amended to depend from claim 25 while claims 12-14, 16 and 17 have been amended to depend from claim 23.

In view of the foregoing amendments to claims 1 and 11, it is submitted all of the claims now in the application comply with the requirements of 35 U.S.C. 112, second paragraph. Therefore, reconsideration and withdrawal of the rejection of claims 1-4 and 6-10 and the rejection of claims 11-18 under 35 U.S.C. 112, second paragraph, are requested.

Claims 1, 3, 4 and 6-10 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,562,786 to Hayashi et al. in view of U.S. Patent

No. 3,561,087 to Koehler et al. Applicants traverse this rejection and request reconsideration thereof.

The present invention relates to a piston ring made of a particular material. The material consists of a steel comprising, by mass, from not less than 0.4 % to less than 1.3 % of C (carbon), 0.1 to 3.0 % of Si, 0.1 to 3.0 % of Mn, from zero (inclusive) to 0.5 % of Cr, 0.05 to 3.0 % of Ni, 0.7 to 2.0 % of Al, 0.3 to 20 % in total (Mo + W + V) of at least one element selected from the group consisting of Mo, W (tungsten) and V (vanadium), and 0.05 to 3.0 % of Cu, wherein graphite particles having an average particle size of not more than 3 μ m are present in a section of a metal structure of a steel.

The Hayashi et al. patent relates to a process for producing a heat-treated sintered iron alloy part having enhanced strength and harness and, in particular, excellent dimensional accuracy, by heat-treating an iron-based sinter obtained by powder metallurgy. The use of the material in oil pumps is mentioned. See, e.g., column 1, lines 65-67 and example 3 at column 7, line 10 et seq. of Hayashi et al. While example of this patent discloses compacting the mixed powder into a ring-shape, there is no disclosure that the material should be used for a piston ring.

Moreover, the Hayashi et al. patent does not describe a piston ring including graphite particles having an average particle size of not more than 3 μ m present in a section of a metal structure of the steel.

The Hayashi et al. patent relates to rotors or gears in oil pumps, which have a size of 40 mm of an outer diameter, 27 mm of an inner diameter and 10 mm of thickness. Referring to Example 3, there is mentioned on a ring-shaped outer rotor of oil pumps. In the present invention, on the other hand, piston rings are produced from a small wires by bending. These wires have a cross sectional area size on the

order of several millimeters, while the ring-shaped outer rotor of Hayashi et al. is a sintered product having a very large size. The outer rotor of an oil pump supplies lubricant oil under pressure to engines or the like while rotating circumferentially together with an inner rotor (see. U.S. Patent No. 6,089,843), for example).

Namely, the outer rotor is used in a non-severe environment quite different from that of the piston rings, so that it can be made of an Al alloy or sintered material which is considerably inferior in strength than piston rings having been produced through forging. On the other hand, in engine operation, piston rings move axially under a very severe environment.

The Koehler patent discloses a piston ring which is a sintered product. However, in view of the differences in operating environments and necessary properties between rotors of oil pumps and piston rings, it is submitted there would have been no reason one of ordinary skill in the art would have combined the teachings of Hayashi et al. and Koehler; i.e., one of ordinary skill in the art would not have not used the material of Hayashi et al. as a piston ring.

Moreover, the Koehler patent also does not disclose a piston ring made of a steel including graphite particles having an average particle size of not more than 3 μm present in a section of the metal structure of the steel.

For the foregoing reasons, the presently claimed invention is patentable over the proposed combination of Hayashi et al. and Koehler.

Claims 1-4 and 6-18 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Hayashi et al. in view of Koehler and further in view of U.S. Patent No. 3,343,953 to Schladitz. Applicants traverse this rejection and request reconsideration thereof.

The deficiencies of the proposed combination of Hayashi et al. and Koehler et al. are noted above. It is submitted the Schladitz patent does not remedy any of these deficiencies.

The Schladitz patent relates to self-lubricating sliding and bearing materials comprising a dry lubricant such as metal sulfides, metal oxides, graphite or the like and to methods of manufacture of such materials. It is disclosed that the material can be manufactured in thin flexible layers, films or strips by incorporating the lubricant particles in a frame work, for instance a thin bronze lattice, and by connecting the particles to the frame work by means of metallization. The material formed in this way can then be rolled up to form rolls, the individual layers of which can be interconnected by one of several methods such as sintering, gluing or metal-ceramic process to form compact bodies. Such rolls can be used in the same manner as composite bearings for mounting and bearing bushings, if necessary. Furthermore, the layers can be glued to rigid supporting surfaces to form sliding surfaces. However, clearly there is no disclosure in Schladitz that would provide any reason for one ordinary skill in the art to make the sintered iron alloy of Hayashi et al. one having observed graphite particles having an average particle size of not more than 3 μm . In fact, the Schladitz patent teaches away from incorporating lubricants into a material forming a sliding surface (see, column 1, line 28-column 2, line 12). Moreover, noting the comments above with respect to Koehler et al., there would have been no reason to modify the teachings of Hayashi et al. or Schladitz et al. to use the material of Hayashi et al. as a piston ring. Accordingly, the presently claimed invention is patentable over the proposed combination of references.

Claims 1-4 and 7-18 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication No. 2002/005616 A1 to Kubota et al. in view of Schladitz. Applicants traverse this rejection and request reconsideration thereof.

The Kubota et al. publication discloses a piston ring material and a piston ring having such properties as the sliding property required in a piston ring and the mechanical properties of a steel wire material subjected to a manufacture process. The piston ring material or the piston ring consists essentially, by mass, of not less than 0.3% but less than 0.8% C, 0.1 to 3.0% Si, 0.1 to 3.0% Mn, 0.03 to 0.3% S, 0.3 to 6.0% Cr, preferably 3.0 to 6.0% or 0.3 to 1.0% Cr, 0 to 3.0% Cu, and the balance Fe, and the distribution state of sulfide inclusions with a maximum diameter/minimum size ≥ 3 observed on structure parallel to the outer peripheral surface of the formed piston ring is such that an intersecting angle made between straight lines passing the maximum size of two of the sulfide inclusions is not more than 30 degrees. Further, the area ratio of nonmetallic inclusions occupying the structure is 2.0% or less, or in addition to the above-described composition, at least one selected from the group consisting of 0.01% or less of Ca, 0.5% or less in total of one or more of V, Nb, Ti, and 1.5% or less of Al is contained.

The Kubota et al. does not disclose a steel having graphite particles having an average particle size of not more than 3 μm present in a section of the metal structure of the steel.

The Schladitz patent relates to self-lubricating sliding and bearing materials comprising a dry lubricant such as metal sulfides, metal oxides, graphite or the like and to methods of manufacture of such materials. It is disclosed that the material can be manufactured in thin flexible layers, films or strips by incorporating the

lubricant particles in a frame work, for instance a thin bronze lattice, and by connecting the particles to the frame work by means of metallization. The material formed in this way can than be rolled up to form rolls, the individual layers of which can be interconnected by one of several methods such as a sintered, gluing or metal-ceramic process to form compact bodies. Such rolls can be used in the same manner as composite bearings for mounting and bearing bushings, if necessary. Furthermore, the layers can be glued to rigid supporting surfaces to form sliding surfaces. However, clearly there is no disclosure in Schladitz that would provide any reason for one ordinary skill in the art to make the sintered iron alloy of Hayashi et al. one having observed graphite particles having an average particle size of not more than 3 μm . In fact, the Schladitz patent teaches away from incorporating lubricants into a material forming a sliding surface (see, column 1, line 28-column 2, line 12) Moreover, noting the comments above with respect to Koehler et al., there would have been no reason to modify the teachings of Kubota et al. or Schladitz et al. to use the material of Kubota et al. as a piston ring. Accordingly, the presently claimed invention is patentable over the proposed combination of references.

Moreover, noting especially claims 23 and 25, it is submitted the Kubota et al. patent would not have provided any reason to provide a piston ring consisting of a steel including by mass, less than 0.3% of Cr. As noted in Applicants' specification, by controlling the amount of elements such as Cr in the steel, complete decomposition of cementite can be accomplished in a short time, even when semi-stable cementite is precipitated. As a result, carbon is precipitated as a graphite at once without substantial formation of cementite. See, e.g., page 16, line 27 to page 17, line 6 and page 21, lines 2-22 of Applicants' specification.

For the foregoing reasons, the presently claimed invention is patentable over the proposed combination of Kubota et al. and Schladitz.

In view of the foregoing amendments and remarks, favorable reconsideration and allowance of all of the claims now in the application are requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 500.44577X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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